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Title 28 EDUCATION

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Title 28 EDUCATION

Part CXXVII. Bulletin 122—Trade and Industrial Education Curricula

Chapter 1. General Provisions

§101. Introduction

A. The National Center for Construction Education and Research (NCCER) is a nonprofit 501(c)(3) foundation for education providing curricula to diversified craft-based businesses. These include industries tied to construction, pipeline, and maintenance. Various industries such as trade associations, construction, schools, contractors, and maintenance users, manufacturers, third-party training providers, and pipeline operators support the efforts of NCCER.

B. The NCCER has coordinated with industry to develop curricula that is respected and acknowledged nationwide. Their curricula are nationally standardized, portable, and competency based. The NCCER has earned the respect and acknowledgement of industry and is partnered with various industry sectors such as construction, pipeline and maintenance. A National Registry has been developed which lists all students who have been awarded industry-based certifications in a number of crafts which allows employers to draw from a workforce they know have been trained by using a nationally consistent curricula.

C. The Louisiana Department of Education (LDE) serves as the state sponsor for NCCER certification for both secondary and postsecondary students. Adoption of common curricula for craft-based courses by both the LDE and Louisiana Technical College (LTC) will facilitate articulation. Upon successful completion of NCCER training, students can earn industry-based certifications in heating, venting, air conditioning, and refrigeration (HVAC-R); carpentry; and electrical. Documentation of these certifications is maintained on the NCCER National Registry offering students a portable credential recognized by industry.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1200 (July 2006).

Chapter 3. Carpentry Competencies/Objectives

§301. Level One

- A. Module 27101-01. Orientation to The Trade
1. Describe the history of the carpentry trade.
 2. Identify the stages of progress within the carpentry trade.
 3. Identify the responsibilities of a person working in the construction industry.

4. State the personal characteristics of a professional.
5. Explain the importance of safety in the construction industry.

B. Module 27102-01. Wood Building Materials, Fasteners, and Adhesives

1. Explain the terms commonly used in discussing wood and lumber.
2. State the uses of various types of hardwoods and softwoods.
3. Identify various types of imperfections that are found in lumber.
4. Explain how lumber is graded.
5. Interpret grade markings on lumber and plywood.
6. Explain how plywood is manufactured, graded, and used.
7. Identify various types of building boards and identify their uses.
8. Identify the uses of and safety precautions associated with pressure-treated and fire-retardant lumber.
9. Describe the proper method of caring for lumber and wood building materials at the job site.
10. State the uses of various types of engineered lumber.
11. Calculate the quantities of lumber and wood products using industry-standard methods.
12. List the basic nail and staple types and their uses.
13. List the basic types of screws and their uses.
14. Identify the different types of anchors and their uses.
15. Describe the common types of adhesives used in construction work and explain their uses.

C. Module 27103-01. Hand and Power Tools

1. Identify the hand tools commonly used by carpenters and describe their uses.
2. Use hand tools in a safe and appropriate manner.
3. State the general safety rules for operating all power tools, regardless of type.
4. State the general rules for properly maintaining all power tools, regardless of type.
5. Identify the portable power tools commonly used by carpenters and describe their uses.

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6. Use portable power tools in a safe and appropriate manner.

7. Identify the stationary power tools commonly used by carpenters and describe their uses.

8. Use stationary power tools in a safe and appropriate manner.

D. Module 27104-01. Floor Systems

1. Identify the different types of framing systems.

2. Read and understand drawings and specifications to determine floor system requirements.

3. Identify floor and sill framing and support members.

4. Name the methods used to fasten sills to the foundation.

5. Given specific floor load and span data, select the proper girder/beam size from a list of available girders/beams.

6. List and recognize different types of floor joists.

7. Given specific floor load and span data, select the proper joist size from a list of available joists.

8. List and recognize different types of bridging.

9. List and recognize different types of flooring materials.

10. Explain the purposes of subflooring and underlayment.

11. Match selected fasteners used in floor framing to their correct uses.

12. Estimate the amount of material needed to frame a floor assembly.

13. Demonstrate the ability to:

a. lay out and construct a floor assembly;

b. install bridging;

c. install joists for a cantilever floor;

d. install a subfloor using butt-joint plywood/OSB panels;

e. install a single floor system using tongue-and-groove plywood/OSB panels.

E. Module 27105-01. Wall and Ceiling Framing

1. Identify the components of a wall and ceiling layout.

2. Describe the procedure for laying out a wood frame wall, including:

a. plates;

b. corner posts;

c. door and window openings;

d. partition Ts;

e. bracing; and

f. firestops.

3. Describe the correct procedure for assembling and erecting an exterior wall.

4. Describe the common materials and methods used for installing sheathing on walls.

5. Lay out, assemble, erect, and brace exterior walls for a frame building.

6. Describe wall framing techniques used in masonry construction.

7. Explain the use of metal studs in wall framing.

8. Describe the correct procedure for laying out a ceiling.

9. Cut and install ceiling joists on a wood frame building.

10. Estimate the materials required to frame walls and ceilings.

F. Module 27106-01. Roof Framing

1. Understand the terms associated with roof framing.

2. Identify the roof framing members used in gable and hip roofs.

3. Identify the methods used to calculate the length of a rafter.

4. Identify the various types of trusses used in roof framing.

5. Use a rafter framing square, speed square, and calculator in laying out a roof.

6. Identify various types of sheathing used in roof construction.

7. Frame a gable roof with vent openings.

8. Frame a roof opening.

9. Construct a frame roof, including:

a. hips;

b. valleys;

c. commons;

d. jack rafters; and

e. sheathing.

10. Erect a gable roof using trusses.

11. Estimate the materials used in framing and sheathing a roof.

G. Module 27107-01. Windows and Exterior Doors

1. Identify various types of fixed, sliding, and swinging windows.

2. Identify the parts of a window installation.

3. State the requirements for a proper window installation.

4. Install a pre-hung window.
5. Identify the common types of skylights and roof windows.
6. Describe the procedure for properly installing a skylight.
7. Identify the common types of exterior doors and explain how they are constructed.
8. Identify the parts of a door installation.
9. Identify the types of thresholds used with exterior doors.
10. Install a threshold on a concrete floor.
11. Install a pre-hung exterior door with weather-stripping.
12. Identify the various types of locksets used on exterior doors and explain how they are installed.
13. Explain the correct installation procedure for a rollup garage door.
14. Install a lockset.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1200 (July 2006).

§303. Level Two

A. Module 27201-01. Reading Plans and Elevations

1. Describe the types of drawings usually included in a set of plans and list the information found on each type.
2. Identify the different types of lines used on construction drawings.
3. Identify selected architectural symbols commonly used to represent materials on plans.
4. Identify selected electrical, mechanical, and plumbing symbols commonly used on plans.
5. Identify selected abbreviations commonly used on plans.
6. Read and interpret plans, elevations, schedules, sections, and details contained in basic construction drawings.
7. State the purpose of written specifications.
8. Identify and describe the parts of a specification.
9. Demonstrate or describe how to perform a quantity takeoff for materials.

B. Module 27202-01. Site Layout One: Distance Measurement and Leveling

1. Describe the major responsibilities of the carpenter relative to site layout.
2. Convert measurements stated in feet and inches to equivalent measurements stated in decimal feet, and vice versa.

3. Use and properly maintain tools and equipment associated with taping.
4. Use taping and/or chaining equipment and procedures to make distance measurements and perform site layout tasks.
5. Determine approximate distances by pacing.
6. Recognize, use, and properly care for tools and equipment associated with differential leveling.
7. Use a builder's level or transit and differential leveling procedures to determine site and building elevations.
8. Record site layout data and information in field notes using accepted practices.
9. Check and/or establish 90° angles using the 3/4/5 rule.

C. Module 27203-01. Introduction to Concrete and Reinforcing Materials

1. Identify various types of cement and describe their uses.
2. Identify types and sizes of concrete aggregates.
3. Identify types of concrete admixtures and describe their uses.
4. Identify special types of concrete and describe their uses.
5. Identify concrete curing methods and materials.
6. Identify concrete testing methods.
7. Demonstrate sampling methods used for the testing of concrete.
8. Perform slump testing of concrete.
9. Perform casting of specimens for strength testing of concrete.
10. Perform volume estimates for concrete quantity requirements.
11. Identify types of concrete reinforcement bars and describe their uses.
12. Identify types of reinforcement bar supports and describe their uses.
13. Identify types of welded-wire fabric (WWF) reinforcement material and describe their uses.

D. Module 27204-01. Foundations and Flatwork

1. Identify various kinds of footings, including:
 - a. continuous or spread;
 - b. stepped;
 - c. pier;
 - d. grade beam.
2. Identify the parts of footing forms and explain their purpose.

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3. Identify the parts of pier forms and explain their purpose.

4. Demonstrate the ability to lay out and construct selected footing forms, including:

- a. continuous footing;
- b. pier footing;
- c. pile cap;
- d. grade beam.

5. Strip a pier footing form and prepare it for erection at another location.

6. Identify types of concrete structures that require the construction of edge forms:

- a. slabs with or without a foundation;
- b. parking lots;
- c. driveways and streets;
- d. sidewalks;
- e. approaches.

7. Identify the parts of edge forms and explain their purpose.

8. Demonstrate the ability to construct and disassemble edge forms for:

- a. a slab-on-grade with an existing foundation;
- b. a slab-on-grade with an integral foundation.

9. Explain the purpose of a screed and identify the different types of screeds.

10. Demonstrate the ability to set screeds on grade.

E. Module 27205-01. Concrete Forms

1. Identify the various types of concrete forms.

2. Identify the components of each type of form.

3. Explain the safety procedures associated with using concrete forms.

4. Erect, plumb, and brace selected concrete forms, including:

- a. basic wall form;
- b. ganged wall form;
- c. radius wall form;
- d. column form;
- e. beam form and shoring;
- f. stair form.

F. Module 27206-01. Reinforcing Concrete

1. Describe the applications of reinforcing bars, the uses of reinforced structural concrete, and the basic processes involved in placing reinforcing bars.

2. Recognize and identify the bar bends standardized by the American Concrete Institute (ACI).

3. Read and interpret bar lists and describe the information found on a bar list.

4. List the types of ties used in securing reinforcing bars.

5. State the tolerances allowed in the fabrication of reinforcing bars.

6. Demonstrate the proper use of common ties for reinforcing bars.

7. Describe methods by which reinforcing bars may be cut and bent in the field.

8. Use the tools and equipment needed for installing reinforcing bars.

9. Demonstrate the ability to safely use selected tools and equipment to cut, bend, and install reinforcing materials.

10. Explain the necessity of concrete cover in placing reinforcing bars.

11. Explain and demonstrate how to place bars in walls, columns, beams, girders, joists, and slabs.

12. Identify lapped and welded splices.

G. Module 27207-01. Handling and Placing Concrete

1. Identify and state the purpose of different types of concrete joints.

2. Recognize the various equipment used to transport and place concrete.

3. Describe the factors that contribute to the quality of concrete placement.

4. Demonstrate and/or describe the correct methods for placing and consolidating concrete into forms.

5. Demonstrate and/or describe how to use a screed to strike off and level concrete to the proper grade in a form.

6. Demonstrate and/or describe how to use a bullfloat and/or darby to level and smooth concrete.

7. Determine when conditions permit the concrete finishing operation to start.

8. Demonstrate and/or describe how to use a hand float and finishing trowel.

9. Demonstrate and/or describe how to use an edger.

10. Demonstrate and/or describe how to use a jointer.

11. Name the factors that affect the curing of concrete and describe the methods used to achieve proper curing.

12. Properly care for and safely use hand and power tools used when working with concrete.

H. Module 27208-01. Manufactured Forms

1. Recognize various types of manufactured forms.

2. Identify the components of manufactured wall-forming systems.
3. State the differences in construction and use among different types of forms.
4. Describe how a flying form system is moved.
5. Erect, plumb, and brace a manufactured wall form.
6. Use a manufactured hardware system to erect forms of lumber and sheathing.
7. Erect, plumb, and brace a manufactured column form.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1201 (July 2006).

§305. Level Three

- A. Module 27301-02. Exterior Finishing
 1. Describe the purpose of wall insulation and flashing.
 2. Identify the types and parts of common cornices.
 3. Demonstrate the installation of selected common cornices.
 4. Demonstrate lap and panel siding estimating methods.
 5. Describe the types and applications of common wood siding:
 - a. beveled;
 - b. tongue-and-groove;
 - c. shiplap;
 - d. board-and-batten;
 - e. shake or shingle;
 - f. plywood;
 - g. hardboard and particleboard.
 6. Install selected types of wood siding.
 7. Describe fiber-cement siding and its uses.
 8. Demonstrate the installation of fiber-cement siding.
 9. Describe the types and styles of vinyl and metal siding.
 10. Install selected types of vinyl or metal siding.
 11. Describe the types and applications of stucco and masonry veneer finishes.
 12. Describe the types and applications of special exterior finish systems.
 13. Describe the types and styles of gutters and downspouts and their accessories.
 14. Install selected types of metal or vinyl gutters and downspouts.

- B. Module 27302-02. Roofing Applications
 1. Identify the materials and methods used in roofing.
 2. Explain the safety requirements for roof jobs.
 3. Install fiberglass shingles on gable and hip roofs.
 4. Close up a valley using fiberglass shingles.
 5. Explain how to make various roof projections watertight when using fiberglass shingles.
 6. Complete the proper cuts and install the main and hip ridge caps using fiberglass shingles.
 7. Lay out, cut, and install a cricket or saddle.
 8. Install wood shingles and shakes on roofs.
 9. Describe how to close up a valley using wood shingles and shakes.
 10. Explain how to make roof projections watertight when using wood shakes and shingles.
 11. Complete the cuts and install the main and hip ridge caps using wood shakes/shingles.
 12. Demonstrate the techniques for installing other selected types of roofing materials.
- C. Module 27303-02. Thermal and Moisture Protection
 1. Describe the requirements for insulation.
 2. Describe the characteristics of various types of insulation material.
 3. Calculate the required amounts of insulation for a structure.
 4. Demonstrate the installation of selected insulation materials.
 5. Describe the requirements for moisture control and ventilation.
 6. Install selected vapor barriers.
 7. Describe various methods of waterproofing.
 8. Describe air infiltration control requirements.
 9. Install selected building wraps.
- D. Module 27304-02. Stairs
 1. Identify the various types of stairs.
 2. Identify the various parts of stairs.
 3. Identify the materials used in the construction of stairs.
 4. Interpret construction drawings of stairs.
 5. Explain the methods of constructing various types of stairs.
 6. Understand the various terms and definitions relating to stairs.
 7. Lay out and cut stringers.

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8. Determine the number and sizes of risers and treads required for a stairway.

9. Build a small stair unit with a handrail.

10. Lay out a skirt board.

E. Module 27305-02. Framing with Metal Studs

1. Identify the components of a metal stud system.

2. Identify and select the tools and fasteners used in a metal stud system.

3. Identify applications for metal stud systems.

4. Lay out and install a metal stud wall with openings.

5. Lay out and install a metal door frame.

6. Lay out and install a metal stud radius wall.

F. MODULE 27306-02. Drywall One: Installation

1. Identify the different types of gypsum wallboard (drywall) and their uses.

2. Select the type and thickness of drywall required for specific installations.

3. Select fasteners for drywall installation.

4. Explain the fastener schedules for different types of drywall installations.

5. Perform single-layer and multi-layer drywall installations using different types of fastening systems, including:

a. nails;

b. drywall screws;

c. adhesives.

6. Install gypsum drywall on metal studs.

7. Explain how soundproofing is achieved in drywall installations.

8. Estimate material quantities for a drywall installation.

G. Module 27307-02. Drywall Two: Finishing

1. Explain the different levels of finishing as defined in A Recommended Specification for Levels of Gypsum Board Finish.

2. Identify the hand tools used in drywall finishing and demonstrate the ability to use these tools.

3. Identify the automatic tools used in drywall finishing.

4. Identify the materials used in drywall finishing and state the purpose and use of each type of material, including:

a. compounds;

b. joint reinforcing tapes;

c. trim materials;

d. textures and coatings.

5. Demonstrate the ability to properly finish drywall using hand tools.

6. Recognize various types of problems that occur in drywall finishes and identify the cause and correct method for solving each type of problem.

7. Demonstrate the ability to patch damaged drywall.

H. Module 27308-02. Interior Finish One: Doors

1. Identify various types of door jambs and frames and demonstrate the installation procedures for placing selected door jambs and frames in different types of interior partitions.

2. Identify different types of interior doors.

3. Identify different types of interior door hardware and demonstrate the installation procedures for selected types.

4. Demonstrate the correct and safe use of the hand tools described in this module.

5. Demonstrate the correct and safe use of the power tools described in this module.

6. List and identify specific items included on a typical door schedule.

7. Demonstrate the procedure for placing and hanging a selected door.

I. Module 27309-02. Interior Finish Two: Suspended Ceilings

1. Establish a level line.

2. Understand the common terms related to sound waves and acoustical ceiling materials.

3. Identify the different types of suspended ceilings.

4. Interpret plans and shop drawings related to ceiling layout.

5. Sketch the ceiling layout for a basic suspended ceiling.

6. Perform a material takeoff for a suspended ceiling.

7. Install selected suspended ceilings.

J. Module 27310-02. Interior Finish Three: Window, Door, Floor, and Ceiling Trim

1. Identify the different types of standard moldings and describe their uses.

2. Make square and miter cuts using a miter box or power miter saw.

3. Make coped joint cuts using a coping saw.

4. Select and properly use fasteners to install trim.

5. Install interior trim, including:

a. door trim;

b. window trim;

- c. base trim;
 - d. ceiling trim;
6. Estimate the quantities of different trim materials required for selected rooms.

K. Module 27311-02. Interior Finish Four: Cabinet Installation

1. State the classes and sizes of typical base and wall kitchen cabinets.
2. Recognize the common types of woods used to make cabinets.
3. Identify cabinet components and hardware and describe their purpose.
4. Install factory-made cabinets, countertops, and backsplashes.
5. Install plastic laminate on a countertop core.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1203 (July 2006).

§307. Level Four

A. Module 27401-03. Site Layout Two: Angular Measurement

1. Perform calculations pertaining to angular measurements.
 - a. Use the Pythagorean theorem to determine unknown values.
 - b. Use right triangle trigonometry to determine unknown values.
 - c. Convert feet and inches to decimal feet, and vice versa.
 - d. Convert angular measurements stated in decimal degrees to degrees, minutes, seconds, and vice versa.
 - e. Convert azimuth to bearing, and vice versa.
 - f. Convert polar coordinates to rectangular coordinates, and vice versa.
 - g. Convert distance and direction into latitudes and departures.
2. Recognize, safely use, and properly care for site layout tools and instruments, including:
 - a. construction laser instruments;
 - b. transits;
 - c. theodolites;
 - d. electronic distance measurement instruments (EDMIs);
 - e. total stations.
3. Lay out building lines using traditional and radial layout techniques.

4. Use a laser level to determine unknown elevations.
5. Use trigonometric leveling techniques to determine unknown elevations.

B. Module 27402-03. Advanced Roof Systems

1. Describe the characteristics and properties of metals as they relate to roofing applications.
2. Identify the types of trusses and joists used in commercial roofing.
3. Demonstrate the installation of panels for a lap seam metal roof, including the preparation of eaves.
4. Demonstrate the installation of panels for a standing seam metal roof.
5. Describe the proper installation procedures for a built-up roof.
6. Demonstrate the installation of endlapped panels for a standing seam metal roof.
7. Demonstrate the sealing of a sidelap standing seam metal roof.

C. Module 27403-03. Advanced Floor Systems

1. Identify different types of floor systems.
2. Explain the purpose of working drawings as they relate to flooring systems.
3. Identify the different types of floor coverings and discuss their applications.
4. Explain the various methods of fireproofing floor systems.
5. Demonstrate the ability to install various types of floor coverings.

D. Module 27404-03. Advanced Wall Systems

1. Explain the different types of wall systems.
2. Explain the different types of wall finishes.
3. Explain the various methods of fireproofing a wall system.
4. Demonstrate the ability to install paneling with wainscoting.
5. Describe the process used in forming and installing tilt-up wall panels.
6. Identify various advanced wall systems and explain the techniques used in their construction.
7. Demonstrate the ability to build penetration firewalls and sound control walls per specifications.

E. Module 27405-03. Advanced Stair Systems

1. Identify the various stair parts.
2. Explain and demonstrate the procedure for cutting and installing various stair parts, including:
 - a. mitered finish stringers;

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- b. mitered risers;
- c. treads;
- d. newel posts;
- e. handrails;
- f. balusters.

3. Describe the method for finishing service stairs and main stairs, and demonstrate instructor-selected finishing for one or more of the following:

- a. open;
- b. closed;
- c. combination open/closed;
- d. L-shaped;
- e. u-shaped

4. Identify what materials can be used to build stairs for commercial construction.

F. Module 27406-03. Introduction to Light Equipment

1. Identify and explain the operation and use of various pieces of light equipment, including:

- a. aerial lifts;
- b. skid steer loaders;
- c. trenchers;
- d. generators;
- e. compressors;
- f. compactors;
- g. forklifts;
- h. backhoe.

2. State the safety precautions associated with light equipment.

3. Operate selected items of light equipment.

G. Module 27407-03. Welding

1. Identify and explain the parts of an oxyfuel cutting outfit.

2. State the safety rules for working with oxyfuel equipment.

3. Identify the proper protective clothing and eye protection to be used in oxyfuel cutting.

4. Explain the meaning of the terms backfire and flashback, describe how to avoid them, and what to do if they occur.

5. Match cutting torch tips to their applications.

6. Under the supervision of the instructor, demonstrate the ability to:

- a. set up equipment for oxyfuel cutting;

b. turn on, light, and adjust the equipment to obtain a neutral flame;

c. cut mild steel, stop, and restart the cut

7. State the safety precautions associated with arc welding.

8. Identify the proper protective clothing and eye protection to be used in welding.

9. Identify the types of arc welding machines.

10. Identify the types of arc welding electrodes.

11. Interpret the meanings of the electrode classification codes.

12. Identify the factors to consider when selecting electrodes.

13. State the characteristics of a good weld.

14. Under the supervision of the instructor, demonstrate the ability to perform one or more of the following welding procedures:

a. start, stop, and restart a bead;

b. construct a pad weld;

c. construct a butt weld;

d. construct a lap-joint fillet weld in the overhead position;

e. construct a T-joint fillet weld in the vertical up position;

f. construct a square-groove butt-joint weld in the vertical down position.

H. Module 27408-03. Metal Buildings

1. Discuss the common applications and basic design principles of metal buildings and contrast them to standard construction.

2. State the safety precautions applicable to metal building assembly, including:

a. power tool safety;

b. rigging safety;

c. electrical safety;

d. concrete-related safety;

e. fall protection;

f. ladder and scaffold safety;

g. welding safety.

3. Describe fastening methods used in metal building construction.

4. Describe the basic erection practices for interior and end bays of metal buildings.

5. Describe the procedures used in plumbing, leveling, and squaring a metal building and contrast them to those used in standard construction.

6. Identify and describe the types of roof panels and roofing materials used on metal buildings.

7. Identify and describe the types of walls and wall finishes used on metal buildings.

8. Describe the procedures used to install windows and doors in metal buildings.

9. Interpret metal building drawings and schematics.

I. Module 27409-03 (Mt101). Introductory Skills for the Crew Leader

1. Discuss current issues and organizational structure in the construction industry today.

2. Understand and incorporate leadership skills into work habits, including:

- a. communication;
- b. motivation;
- c. team building;
- d. problem solving; and
- e. decision-making skills.

3. Demonstrate an awareness of safety issues, including the cost of accidents and safety regulations.

4. Identify a supervisor's typical safety responsibilities.

5. Show a basic understanding of the planning process, scheduling, and cost and resource control.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1204 (July 2006).

§309. Level Five

A. Module 27501-03. Cabinetmaking

1. State the classes and sizes of typical base and wall kitchen cabinets.

2. Recognize the common types of woods used to make cabinets.

3. Identify cabinet components and hardware and describe their purpose.

4. Correctly and safely use stationary power tools.

5. Identify and cut the various types of joints used in cabinetmaking.

6. Build a cabinet from a set of drawings.

7. Install plastic laminate on a countertop core.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1206 (July 2006).

Chapter 5. Electrical Competencies/Objectives

§501. Level One

A. Module 26101-02. Electrical Safety

1. Demonstrate safe working procedures in a construction environment.

2. Explain the purpose of OSHA and how it promotes safety on the job.

3. Identify electrical hazards and how to avoid or minimize them in the workplace.

4. Explain:

a. safety issues concerning lockout/tagout procedures;

b. personal protection using assured grounding and isolation programs, confined space entry, respiratory protection; and

c. fall protection systems.

B. Module 26102-02. Hand Bending

1. Identify the methods of hand bending conduit.

2. Identify the various methods used to install conduit.

3. Use math formulas to determine conduit bends.

4. Make 90° bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.

5. Cut, ream, and thread conduit.

C. Module 26103-02. Fasteners and Anchors

1. Identify and explain the use of threaded fasteners.

2. Identify and explain the use of non-threaded fasteners.

3. Identify and explain the use of anchors.

4. Demonstrate the correct applications for fasteners and anchors.

5. Install fasteners and anchors.

D. Module 26104-02. Electrical Theory One

1. Recognize what atoms are and how they are constructed.

2. Define voltage and identify the ways in which it can be produced.

3. Explain the difference between conductors and insulators.

4. Define the units of measurement that are used to measure the properties of electricity.

5. Explain how voltage, current, and resistance are related to each other.

EDUCATION

6. Using the formula for Ohm's Law, calculate an unknown value.

7. Explain the different types of meters used to measure voltage, current, and resistance.

8. Using the power formula, calculate the amount of power used by a circuit.

E. Module 26105-02. Electrical Theory Two

1. Explain the basic characteristics of a series circuit.

2. Explain the basic characteristics of a parallel circuit.

3. Explain the basic characteristics of a series-parallel circuit.

4. Calculate, using Kirchoff's Voltage Law, the voltage drop in series, parallel, and series-parallel circuits.

5. Calculate, using Kirchoff's Current Law, the total current in parallel and series-parallel circuits.

6. Find the total amount of resistance in a series circuit.

7. Find the total amount of resistance in a parallel circuit.

8. Find the total amount of resistance in a series-parallel circuit.

F. Module 26106-02. Electrical Test Equipment

1. Explain the operation of and describe the following pieces of test equipment:

- a. ammeter;
- b. ohmmeter;
- c. wattmeter;
- d. frequency meter;
- e. continuity tester;
- f. recording instruments;
- g. voltmeter;
- h. volt-ohm-millimeter (VOM);
- i. megohmmeter;
- j. power factor meter;
- k. voltage tester;
- l. cable-length meters.

2. Explain how to read and convert from one scale to another using the test equipment listed in Subparagraphs a-l above.

3. Explain the importance of proper meter polarity.

4. Define frequency and explain the use of a frequency meter.

5. Explain the difference between digital and analog meters.

G. Module 26107-02. Introduction to The National Electrical Code®

1. Explain the purpose and history of the National Electrical Code® (NEC®).

2. Describe the layout of the NEC®.

3. Explain how to navigate the NEC®.

4. Describe the purpose of the National Electrical Manufacturers' Association (NEMA) and the National Fire Protection Association (NFPA).

5. Explain the role of testing laboratories.

H. Module 26108-02. Raceways, Boxes, and Fittings

1. Describe various types of cable trays and raceways.

2. Identify and select various types and sizes of raceways.

3. Identify and select various types and sizes of cable trays.

4. Identify and select various types of raceway fittings.

5. Identify various methods used to install raceways.

6. Demonstrate knowledge of NEC® raceway requirements.

7. Describe procedures for installing raceways and boxes on masonry surfaces.

8. Describe procedures for installing raceways and boxes on concrete surfaces.

9. Describe procedures for installing raceways and boxes in a metal stud environment.

10. Describe procedures for installing raceways and boxes in a wood frame environment.

11. Describe procedures for installing raceways and boxes on drywall surfaces.

12. Recognize safety precautions that must be followed when working with boxes and raceways.

I. Module 26109-02. Conductors

1. Explain the various sizes and gauges of wire in accordance with American Wire Gauge standards.

2. Identify insulation and jacket types according to conditions and applications.

3. Describe voltage ratings of conductors and cables.

4. Read and identify markings on conductors and cables.

5. Use the tables in the NEC® to determine the ampacity of a conductor.

6. State the purpose of stranded wire.

7. State the purpose of compressed conductors.

8. Describe the different materials from which conductors are made.

9. Describe the different types of conductor insulation.
10. Describe the color coding of insulation.
11. Describe instrumentation control wiring.
12. Describe the equipment required for pulling wire through conduit.
13. Describe the procedure for pulling wire through conduit.
14. Install conductors in conduit.
15. Pull conductors in a conduit system.

J. Module 26110-02. Introduction to Electrical Blueprints

1. Explain the basic layout of a blueprint.
2. Describe the information included in the title block of a blueprint.
3. Identify the types of lines used on blueprints.
4. Identify common symbols used on blueprints.
5. Understand the use of architect's and engineer's scales.
6. Interpret electrical drawings, including:
 - a. site plans;
 - b. floor plans; and
 - c. detail drawings.
7. Read equipment schedules found on electrical blueprints.
8. Describe the type of information included in electrical specifications.

K. Module 26111-02. Wiring: Commercial and Industrial

1. Identify and state the functions and ratings of single-pole, double-pole, three-way, four-way, dimmer, special, and safety switches.
2. Explain NEMA classifications as they relate to switches and enclosures.
3. Explain the NEC® requirements concerning wiring devices.
4. Identify and state the functions and ratings of straight blade, twist lock, and pin and sleeve receptacles.
5. Identify and define receptacle terminals and disconnects.
6. Identify and define ground fault circuit interrupters.
7. Explain the box mounting requirements in the NEC®.
8. Use a wire stripper to strip insulation from a wire.
9. Use a solderless connector to splice wires together.
10. Identify and state the functions of limit switches and relays.

11. Identify and state the function of switchgear.

L. Module 26112-02. Wiring: Residential

1. Describe how to determine electric service requirements for dwellings.
2. Explain the grounding requirements of a residential electric service.
3. Calculate and select service-entrance equipment.
4. Select the proper wiring methods for various types of residences.
5. Explain the role of the NEC® in residential wiring.
6. Compute branch circuit loads and explain their installation requirements.
7. Explain the types and purposes of equipment grounding conductors.
8. Explain the purpose of ground fault circuit interrupters and tell where they must be installed.
9. Size outlet boxes and select the proper type for different wiring methods.
10. Describe rules for installing electric space heating and HVAC equipment.
11. Describe the installation rules for electrical systems around swimming pools, spas, and hot tubs.
12. Explain how wiring devices are selected and installed.
13. Describe the installation and control of lighting fixtures.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1206 (July 2006).

§503. Level Two

A. Module 26201-03. Alternating Current

1. Calculate the peak and effective voltage or current values for an AC waveform.
2. Calculate the phase relationship between two AC waveforms.
3. Describe the voltage and current phase relationship in a resistive AC circuit.
4. Describe the voltage and current transients that occur in an inductive circuit.
5. Define inductive reactance and state how it is affected by frequency.
6. Describe the voltage and current transients that occur in a capacitive circuit.
7. Define capacitive reactance and state how it is affected by frequency.

EDUCATION

8. Explain the relationship between voltage and current in the following types of AC circuits:

- a. RL circuit;
- b. LC circuit;
- c. RC circuit;
- d. RLC circuit.

9. Describe the effect that resonant frequency has on impedance and current flow in a series or parallel resonant circuit.

10. Define bandwidth and describe how it is affected by resistance in a series or parallel resonant circuit.

11. Explain the following terms as they relate to AC circuits:

- a. true power;
- b. reactive power;
- c. apparent power;
- d. power factor.

12. Explain basic transformer action.

B. Module 26202-03. Motors: Theory and Application

1. Define the following terms:

- a. ampacity;
- b. branch circuit;
- c. circuit breaker;
- d. controller;
- e. duty;
- f. equipment;
- g. full-load amps;
- h. remote control circuit;
- i. interrupting rating;
- j. motor circuit switch;
- k. thermal protector;
- l. NEMA design letter;
- m. nonautomatic;
- n. overcurrent;
- o. overload;
- p. power factor;
- q. rated full-load speed;
- r. rated horsepower;
- s. ground fault circuit interrupter;
- t. service factor;
- u. thermal cutout.

2. Describe the various types of motor enclosures.

3. Describe how the rated voltage of a motor differs from the system voltage.

4. Describe the basic construction and components of a three-phase squirrel cage induction motor.

5. Explain the relationships among speed, frequency, and the number of poles in a three-phase induction motor.

6. Describe how torque is developed in an induction motor.

7. Explain how and why torque varies with rotor reactance and slip.

8. Define percent slip and speed regulation.

9. Explain how the direction of a three-phase motor is reversed.

10. Describe the component parts and operating characteristics of a three-phase wound-rotor induction motor.

11. Describe the component parts and operating characteristics of a three-phase synchronous motor.

12. Define torque, starting current, and armature reaction as they apply to DC motors.

13. Explain how the direction of rotation of a DC motor is changed.

14. Describe the design and characteristics of a DC shunt, series, and compound motor.

15. Describe dual-voltage motors and their applications.

16. Describe the methods for determining various motor connections.

17. Describe general motor protection requirements as delineated in the NEC®.

C. Module 26203-03. Grounding

1. Explain the purpose of grounding and the scope of NEC Article 250.

2. Distinguish between a short circuit and a ground fault.

3. Define the NEC® ground-related terms.

4. Distinguish between system grounding and equipment grounding.

5. Use NEC® Table 250.66 to size the grounding electrode conductor for various AC systems.

6. Explain the NEC® requirements for the installation and physical protection of grounding electrode conductors.

7. Explain the function of the grounding electrode system and determine which grounding electrodes must be used.

8. Define electrodes and explain the resistance requirements for electrodes using NEC® Section 250.56.

9. Use NEC® Table 250.122 to size the equipment grounding conductor for raceways and equipment.

10. Explain the function of the main bonding jumper in the grounding system and size the main bonding jumper for various applications.

11. Size the main bonding jumper for a service utilizing multiple service disconnecting means.

12. Explain the NEC® requirements for bonding of enclosures and equipment.

13. Explain the NEC® requirements for grounding of enclosures and equipment.

14. Explain effectively grounded and its importance in clearing ground faults and short circuits.

15. Explain the purposes of the grounded conductor (neutral) in the operation of overcurrent devices.

16. Explain the NEC® requirements for grounding separately-derived systems, including transformers and generators.

17. Explain the NEC® requirements for grounding at more than one building.

18. Explain the NEC® grounding requirements for systems over 600 volts.

D. Module 26204-03. Conduit Bending

1. Describe the process of conduit bending using power tools.

2. Identify all parts of popular electric and hydraulic benders.

3. Avoid excessive waste when working with conduit systems.

4. Bend offsets, kicks, saddles, segmented, and parallel bends.

5. Explain the requirements of the NEC® for bending conduit.

6. Compute the radius, degrees in bend, developed length, and gain for conduit up to 6 inches.

7. Explain how to correct damaged conduit and modify existing bends.

E. Module 26205-03. Boxes and Fittings

1. Describe the different types of nonmetallic and metallic boxes.

2. Understand the NEC® requirements for box fill.

3. Calculate the required box size for any number and size of conductors.

4. Explain the NEC® regulations for volume required per conductor in outlet boxes.

5. Properly locate, install, and support boxes of all types.

6. Describe the NEC® regulations governing pull and junction boxes.

7. Explain the radius rule when installing conductors in pull boxes.

8. Understand the NEC® requirements for boxes supporting lighting fixtures.

9. Describe the purpose of conduit bodies and Type FS boxes.

10. Install the different types of fittings used in conjunction with boxes.

11. Describe the installation rules for installing boxes and fittings in hazardous areas.

12. Explain how boxes and fittings are selected and installed.

13. Describe the various types of box supports.

F. Module 26206-03. Conductor Installations

1. Describe the various methods of installing conductors in conduit.

2. Plan and set up for a cable pull.

3. Understand the importance of selecting the proper location for cable pulls.

4. Describe how cable reels are transported to the pulling site.

5. Set up reel stands and spindles for a wire-pulling installation.

6. Explain how mandrels, swabs, and brushes are used to prepare conduit for conductors.

7. Properly install a pull line for a cable-pulling operation.

8. Explain the operation of power fish tape systems.

9. Prepare the ends of conductors for pulling.

10. Describe the types of cable pullers.

11. Describe the process of high-force cable pulling.

12. Explain how to support conductors in vertical conduit runs.

13. Describe the installation of cables in cable trays.

14. Explain the importance of communication during a cable-pulling operation.

15. Calculate the probable stress or tension in cable pulls.

G. Module 26207-03. Cable Tray

1. Describe the components that make up a cable tray assembly.

2. Explain the methods used to hang and secure cable tray.

3. Describe how cable enters and exits cable tray.

EDUCATION

4. Select the proper cable tray fitting for the situation.
5. Explain the NEMA standards for cable tray installations.
6. Explain the NEC® requirements for cable tray installations.
7. Select the required fittings to ensure equipment grounding continuity in cable tray systems.
8. Interpret electrical working drawings showing cable tray fittings.
9. Size cable tray for the number and type of conductors contained in the system.
10. Select rollers and sheaves for pulling cable in specific cable tray situations.
11. Designate the required locations of rollers and sheaves for a specific cable pull.

H. Module 26208-03. Conductor Terminations and Splices

1. Describe how to make a good conductor termination.
2. Prepare cable ends for terminations and splices.
3. Install lugs and connectors onto conductors.
4. Train cable at termination points.
5. Explain the role of the NEC® in making cable terminations and splices.
6. Explain why mechanical stress should be avoided at cable termination points.
7. Describe the importance of using proper bolt torque when bolting lugs onto busbars.
8. Describe crimping techniques.
9. Select the proper lug or connector for the job.
10. Describe splicing techniques.
11. Explain how to use hand and power crimping tools.

I. Module 26209-03. Installation of Electric Services

1. Describe various types of electric services for commercial and industrial installations.
2. Read electrical blueprints and diagrams describing service installations.
3. Calculate and select service-entrance equipment.
4. Explain the role of the NEC® in service installations.
5. Install main disconnect switches, panelboards, and overcurrent protection devices.
6. Identify the circuit loads, number of circuits required, and installation requirements for distribution panels.
7. Explain the types and purposes of service grounding.

8. Explain the purpose and required location(s) of ground fault circuit interrupters.
9. Describe single-phase service connections.
10. Describe both wye- and delta-connected three-phase services.

J. Module 26210-03. Circuit Breakers and Fuses

1. Explain the necessity of overcurrent protection devices in electrical circuits.
2. Define the terms associated with fuses and circuit breakers.
3. Describe the operation of a circuit breaker.
4. Select the most suitable overcurrent device for the application.
5. Explain the role of the NEC® in specifying overcurrent devices.
6. Describe the operation of single-element and time-delay fuses.
7. Explain how ground fault circuit interrupters (GFCIs) can save lives.
8. Calculate short circuit currents.
9. Describe troubleshooting and maintenance techniques for overcurrent devices.

K. Module 26211-03. Contactors and Relays

1. Describe the operating principles of contactors and relays.
2. Select contactors and relays for use in specific electrical systems.
3. Explain how mechanical contactors operate.
4. Explain how solid-state contactors operate.
5. Install contactors and relays according to the NEC® requirements.
6. Select and install contactors and relays for lighting control.
7. Read wiring diagrams involving contactors and relays.
8. Describe how overload relays operate.
9. Connect a simple control circuit.
10. Test control circuits.

L. Module 26212-03. Electric Lighting

1. Explain how the human eye works.
2. Describe the characteristics of light.
3. Recognize the different kinds of lamps and explain the advantages and disadvantages of each type:
 - a. incandescent;
 - b. fluorescent;

- c. halogen;
 - d. high-intensity discharge (HID).
4. Properly select and install lamps into lighting fixtures.
 5. Recognize and install various types of lighting fixtures:
 - a. surface-mounted;
 - b. suspended;
 - c. recessed;
 - d. track-mounted.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1208 (July 2006).

§505. Level Three

A. Module 26301-02. Load Calculators—Branch and Feeder Circuits

1. Calculate loads for single-phase and three-phase branch circuits.
2. Size branch circuit overcurrent protection devices (circuit breakers and fuses) for noncontinuous duty and continuous duty circuits.
3. Apply derating factors to size branch circuits.
4. Calculate ampacity for single-phase and three-phase loads.
5. Use load calculations to determine branch circuit conductor sizes.
6. Use NEC® Table 220-19 to calculate residential cooking equipment loads.
7. Select branch circuit conductors and overcurrent protection devices for:
 - a. electric heat;
 - b. air conditioning equipment;
 - c. motors; and
 - d. welders.

B. Module 26302-02. Conductor Selection and Calculations

1. Select electrical conductors for specific applications.
2. Calculate voltage drop in both single-phase and three-phase applications.
3. Apply NEC® regulations governing conductors to a specific application.
4. Calculate and apply NEC® tap rules to a specific application.
5. Size conductors for the load.

6. Derate conductors for fill, temperature, and voltage drop.
7. Select conductors for various temperature ranges and atmospheres.

C. Module 26303-02. Overcurrent Protection

1. Apply the key NEC® requirements regarding overcurrent protection.
2. Check specific applications for conformance to NEC® sections that cover short circuit current, fault currents, interrupting ratings, and other sections relating to overcurrent protection.
3. Determine let-through current values (peak and rms) when current-limiting overcurrent devices are used.
4. Select and size overcurrent.

D. Module 26304-02. Raceway, Box, and Fitting Fill Requirements

1. Size raceways according to conductor fill and NEC installation requirements.
2. Size outlet boxes according to NEC® installation requirements.
3. Size and select pull and junction boxes according to NEC® installation requirements.
4. Calculate conduit fill using a percentage of the trade size conduit inside diameter (ID).
5. Calculate the required bending radius in boxes and cabinets.

E. Module 26305-02. Wiring Devices

1. Select wiring devices according to the National Electrical Manufacturers' Association (NEMA) classifications.
2. Size wiring devices in accordance with NEC® requirements.
3. Discuss the NEMA enclosure classifications.
4. Follow NEC® regulations governing the installation of wiring devices.
5. Explain the types and purposes of grounding wiring devices.
6. Determine the maximum load allowed on specific wiring devices.

F. Module 26306-02. Distribution Equipment

1. Describe the purpose of switchgear.
2. Describe the four general classifications of circuit breakers and list the major circuit breaker ratings.
3. Describe switchgear construction, metering layouts, wiring requirements, and maintenance.
4. List NEC® requirements pertaining to switchgear.

EDUCATION

5. Describe the visual and mechanical inspections and electrical tests associated with low-voltage and medium-voltage cables, metal-enclosed busways, and metering and instrumentation.

6. Describe a ground fault relay system and explain how to test it.

G. Module 26307-02. Distribution System Transformers

1. Describe transformer operation.

2. Explain the principle of mutual induction.

3. Describe the operating characteristics of various types of transformers.

4. Connect a multi-tap transformer for the required secondary voltage.

5. Explain NEC® requirements governing the installation of transformers.

6. Compute transformer sizes for various applications.

7. Explain types and purposes of grounding transformers.

8. Connect a control transformer for a given application.

9. Size the maximum load allowed on open delta systems.

10. Describe how current transformers are used in conjunction with watt-hour meters.

11. Apply capacitors and rectifiers to practical applications.

12. Calculate the power factor of any given electrical circuit.

H. Module 26308-02. Lamps, Ballasts, and Components

1. Recognize incandescent, fluorescent, and high-intensity discharge (HID) lamps and describe how each type of lamp operates.

2. Recognize ballasts and describe their purpose for use in fluorescent and HID lighting fixtures.

3. Explain the relationship of Kelvin temperature to the color of light produced by a lamp.

4. Recognize basic occupancy sensors, photoelectric sensors, and timers used to control lighting circuits and describe how each device operates.

5. Use troubleshooting checklists to troubleshoot fluorescent and HID lamps and lighting fixtures.

I. Module 26309-02. Motor Calculations

1. Size branch circuits and feeders for electric motors.

2. Size and select overcurrent protective devices for motors.

3. Size and select overload relays for electric motors.

4. Size and select devices to improve the power factor at motor locations.

5. Size motor short circuit protectors.

6. Size multi-motor branch circuits.

7. Size motor disconnects.

J. Module 26310-02. Motor Maintenance, Part One

1. Properly store motors and generators.

2. Test motors and generators.

3. Make connections for specific types of motors and generators.

4. Clean open-frame motors.

5. Lubricate motors that require this type of maintenance.

6. Collect and record motor data.

7. Select tools for motor maintenance.

8. Select instruments for motor testing.

K. Module 26311-02. Motor Controls

1. Identify contactors and relays both physically and schematically and describe their operating principles.

2. Identify pilot devices both physically and schematically and describe their operating principles.

3. Interpret motor control wiring, connection, and ladder diagrams.

4. Select and size contactors and relays for use in specific electrical motor control systems.

5. Select and size pilot devices for use in specific electrical motor control systems.

6. Connect motor controllers for specific applications according to NEC® requirements.

L. Module 26312-02. Hazardous Locations

1. Define the various classifications of hazardous locations.

2. Describe the wiring methods permitted for branch circuits and feeders in specific hazardous locations.

3. Select seals and drains for specific hazardous locations.

4. Select wiring methods for Class I, Class II, and Class III hazardous locations.

5. Follow NEC® requirements for installing explosionproof fittings in specific hazardous locations.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1210 (July 2006).

§507. Level Four**A. Module 26401-03. Load Calculations–Feeders and Services**

1. Size feeders and services in accordance with NEC® requirements.
2. Calculate loads and ampacities for single-phase and three-phase feeders.
3. Understand and apply derating factors to size feeders.
4. Size feeder overcurrent protection devices (circuit breakers and fuses) for non-continuous duty and continuous duty loads.
5. Understand and apply tap rules.
6. Calculate loads for a retail store with a show window.
7. Calculate loads for an office building.
8. Calculate loads for both single-family and multi-family dwellings.
9. Calculate loads for a restaurant.
10. Calculate loads for hotels and motels.
11. Calculate loads for schools and other institutional projects.
12. Perform feeder and service calculations for farms.
13. Calculate the power and supply feeders for marinas and boatyards.
14. Calculate electric motor loads on feeders.

B. Module 26402-03. Practical Applications of Lighting

1. Explain how the lighting terms lumen, candlepower, and footcandle relate to one another.
2. Classify lighting fixtures by layout, location, fixture type, and type of service.
3. Identify the basic design configurations of incandescent, fluorescent, and HID lighting fixtures and describe the general lighting pattern (direct, indirect, etc.) produced by each type.
4. Identify the main lighting requirements associated with lighting systems used in selected applications such as office buildings, schools, theaters, etc.
5. Identify the special wiring and dimming system components used with incandescent, fluorescent, and HID lighting systems.
6. Use manufacturer's lighting fixture catalogs to select the appropriate lighting fixtures for specific lighting applications.

C. Module 26403-03. Standby and Emergency Systems

1. Explain the basic differences between emergency systems, legally required standby systems, and optional standby systems.
2. Describe the operating principles of an engine-driven standby AC generator.
3. Describe the different types and characteristics of standby and emergency generators.
4. Recognize and describe the operating principles of both automatic and manual transfer switches.
5. Recognize the different types of storage batteries used in emergency and standby systems and explain how batteries charge and discharge.
6. For selected types of batteries, describe their characteristics, applications, maintenance, and testing.
7. Recognize double-conversion and single-conversion types of uninterruptible power supplies (UPSs) and describe how they operate.
8. Describe the NEC requirements that pertain to the installation of standby and emergency power systems.

D. Module 26404-03. Basic Electronic Theory

1. Identify electronic system components.
2. Describe the electrical characteristics of solid-state devices.
3. Describe the basic materials that make up solid-state devices.
4. Describe and identify the various types of transistors, and explain how they operate.
5. Interpret electronic schematic diagrams.
6. Describe and connect diodes.
7. Describe and connect light-emitting diodes (LEDs).
8. Describe and connect silicon-controlled rectifiers (SCRs).
9. Identify the leads of various solid-state devices.

E. Module 26405-03. Fire Alarm Systems

1. Understand the unique terminology associated with fire alarm systems.
2. Describe the relationship between fire alarm systems and life safety.
3. Identify and explain the role that various codes and standards play in both commercial and residential fire alarm applications.
4. Describe the characteristics and functions of various fire alarm system components.
5. Explain and describe the different types of circuitry that connect fire alarm system components.

EDUCATION

6. Describe the theory behind conventional, addressable, and analog fire alarm systems and explain how these systems function.

F. Module 26406-03. Specialty Transformers

1. Identify power transformer connections.
2. Identify specialty transformers.
3. Size and select buck-and-boost transformers.
4. Connect current and potential transformers.
5. Calculate and install overcurrent protection for specialty transformers.
6. Ground specialty transformers according to NEC® requirements.
7. Size, install, and connect control, shielded, constant-current, and other specialty transformers.
8. Check additive and subtractive polarities.
9. Derate transformers to account for the effects of harmonics.

G. Module 26407-03. Advanced Motor Controls

1. Select and install solid-state relays for specific applications in motor control circuits.
2. Install non-programmable/programmable motor circuit protectors (solid-state overload relays) in accordance with the manufacturer's instructions.
3. Select and install electromechanical and solid-state timing relays for specific applications in motor control circuits.
4. Recognize the different types of reduced-voltage starting motor controllers and describe their operating principles.
5. Connect and program adjustable frequency drives to control a motor in accordance with the manufacturer's instructions.
6. Demonstrate and/or describe the special precautions used when handling and working with solid-state motor controls.
7. Recognize common types of motor braking and explain the operating principles of motor brakes.
8. Perform preventive maintenance and troubleshooting tasks in motor control circuits.

H. Module 26408-03. HVAC Controls

1. Identify the major mechanical components common to all HVAC systems.
2. Explain the function of a thermostat in an HVAC system.
3. Describe different types of thermostats and explain how they are used.

4. Demonstrate the correct installation and adjustment of a thermostat using proper siting and wiring techniques.

5. Explain the basic principles applicable to all control systems.

6. Identify the various types of electromechanical and electronic HVAC controls, and explain their function and operation.

7. State the NEC® requirements applicable to HVAC controls.

I. Module 26409-03. Heat Tracing and Freeze Protection

1. Identify and describe the purpose for electric heat tracing equipment used with pipelines and vessels.
2. Select, size, and install electric heat tracing equipment on selected pipelines and vessels in accordance with the manufacturer's instructions and NEC® requirements.
3. Identify and describe the purpose for electric heating equipment used with roof, gutter, and downspout de-icing systems.
4. Select, size, and install selected roof, gutter, and downspout de-icing systems in accordance with the manufacturer's instructions and NEC® requirements.
5. Identify and describe the purpose for electric heating equipment used with snow-melting and anti-icing systems.
6. Select, size, and install selected snow-melting and anti-icing systems in accordance with the manufacturer's instructions and NEC® requirements.
7. Identify and describe the purpose for electric heat tracing equipment used with domestic hot-water temperature maintenance systems.
8. Select, size, and install selected electric heat traced domestic hot-water systems in accordance with the manufacturer's instructions and NEC® requirements.
9. Identify and describe the purpose for electric floor heating/warming systems.
10. Select, size, and install selected electric floor heating/warming systems in accordance with the manufacturer's instructions and NEC® requirements.

J. Module 26410-03. Motor Maintenance, Part Two

1. Test motor winding resistance.
2. Select and use motor testing equipment.
3. Clean and test open frame motors.
4. Clean, dry, and test motors that have been subjected to water damage.
5. Troubleshoot and repair electric motors.

K. Module 26411-03. High Voltage Terminations/Splices

1. Select proper materials and tools for high-voltage terminations and splices.

2. Prepare high-voltage cable for terminations and splices.
3. Complete cable assemblies with terminations and splices.
4. Inspect and test high-voltage terminations and splices.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1212 (July 2006).

Chapter 7. Heating, Ventilation and Air Conditioning Competencies/Objectives

§701. Level One

A. Module 03101-01. Introduction to Heating, Ventilation and Air Conditioning (HVAC)

1. Explain the basic principles of heating, ventilation, and air conditioning.
2. Identify career opportunities available to people in the HVAC trade.
3. Explain the purpose and objectives of an apprentice training program.
4. Describe how certified apprentice training can start in high school.
5. Describe what the Clean Air Act means to the HVAC trade.

B. Module 03102-01. Trade Mathematics

1. Identify similar units of measurement in both the inch-pound (English) and metric systems and know which units are larger.
2. Convert measured values in the inch-pound system to equivalent metric values and vice versa.
3. Express numbers as powers of 10.
4. Determine the powers and roots of numbers.
5. Solve basic algebraic equations.
6. Recognize various geometric figures.
7. Use the Pythagorean theorem to make calculations involving right triangles.
8. Convert decimal feet to feet and inches and vice versa.

C. Module 03103-01. Tools of the Trade

1. Identify and state the use of the following tools:
 - a. pipe wrenches;
 - b. torque wrenches;
 - c. tinner's and soft-faced hammers;
 - d. hand cutting snips;

- e. hand and power hacksaws;
- f. drill press;
- g. measuring tools.

2. Describe the general procedures for maintenance of most hand and power tools.

3. Describe or demonstrate the general safety precautions that must be followed when using most hand and power tools.

D. Module 03104-01. Copper and Plastic Piping Practices

1. State the precautions that must be taken when installing refrigerant piping.
2. Select the right tubing for a job.
3. Cut and bend tubing.
4. Safely join tubing by using flare and compression fittings.
5. Determine the kinds of hangers and supports needed for refrigerant piping.
6. State the basic requirements for pressure-testing a system once it has been installed.

E. Module 03105-01. Soldering and Brazing

1. Assemble and operate the tools used for soldering.
2. Prepare tubing and fittings for soldering.
3. Identify the purposes and uses of solder and solder fluxes.
4. Solder copper tubing and fittings.
5. Assemble and operate the tools used for brazing.
6. Prepare tubing and fittings for brazing.
7. Identify the purposes and uses of filler metals and fluxes used for brazing.
8. Braze copper tubing and fittings.
9. Identify the inert gases that can safely be used to purge tubing when brazing.

F. Module 03106-01. Ferrous Metal Piping Practices

1. Identify the types of ferrous metal pipes.
2. Measure the sizes of ferrous metal pipes.
3. Identify the common malleable iron fittings.
4. Cut, ream, and thread ferrous metal pipe.
5. Join lengths of threaded pipe together and install fittings.
6. Describe the main points to consider when installing pipe runs.
7. Describe the method used to join grooved piping.

G. Module 03107-01. Basic Electricity

EDUCATION

1. State how electrical power is generated and distributed.
2. Describe how voltage, current, resistance, and power are related.
3. Use Ohm's law to calculate the current, voltage, and resistance in a circuit.
4. Use the power formula to calculate how much power is consumed by a circuit.
5. Describe the differences between series and parallel circuits.
6. Recognize and describe the purpose and operation of the various electrical components used in HVAC equipment.
7. State and demonstrate the safety precautions that must be followed when working on electrical equipment.
8. Make voltage, current, and resistance measurements using electrical test equipment.

H. Module 03108-01. Introduction to Cooling

1. Explain how heat transfer occurs in a cooling system, demonstrating an understanding of the terms and concepts used in the refrigeration cycle.
2. Calculate the temperature and pressure relationships at key points in the refrigeration cycle.
3. Under supervision, use temperature- and pressure-measuring instruments to make readings at key points in the refrigeration cycle.
4. Identify commonly used refrigerants and demonstrate the procedures for handling these refrigerants.
5. Identify the major components of a cooling system and explain how each type works.
6. Identify the major accessories available for cooling systems and explain how each type works.
7. Identify the control devices used in cooling systems and explain how each type works.
8. State the correct methods to be used when piping a refrigeration system.

I. Module 03109-01. Introduction to Heating

1. Explain the three methods by which heat is transferred and give an example of each.
2. Describe how combustion occurs and identify the by-products of combustion.
3. Identify the various types of fuels used in heating.
4. Identify the major components and accessories of a forced-air furnace and explain the function of each component.
5. State the factors that must be considered when installing a furnace.
6. Identify the major components of a gas furnace and describe how each works.

7. With supervision, use a manometer to measure and adjust manifold pressure on a gas furnace.
8. Identify the major components of an oil furnace and describe how each works.
9. Describe how an electric furnace works.
10. With supervision, perform basic furnace preventive maintenance procedures such as cleaning and filter replacement.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1213 (July 2006).

§703. Level Two

A. Module 03201-01. Air Distribution Systems

1. Describe the airflow and pressures in a basic forced-air distribution system.
2. Explain the differences between propeller and centrifugal fans and blowers.
3. Identify the various types of duct systems and explain why and where each type is used.
4. Demonstrate or explain the installation of metal, fiberboard, and flexible duct.
5. Demonstrate or explain the installation of fittings and transitions used in duct systems.
6. Demonstrate or explain the use and installation of diffusers, registers, and grilles used in duct systems.
7. Demonstrate or explain the use and installation of dampers used in duct systems.
8. Demonstrate or explain the use and installation of insulation and vapor barriers used in duct systems.
9. Identify the instruments used to make measurements in air systems and explain the use of each instrument.
10. Make basic temperature, air pressure, and velocity measurements in an air distribution system.

B. Module 03202-01. Chimneys, Vents, and Flues

1. Describe the principles of combustion and explain complete and incomplete combustion.
2. Describe the content of flue gas and explain how it is vented.
3. Identify the components of a furnace vent system.
4. Describe how to select and install a vent system.
5. Perform the adjustments necessary to achieve proper combustion in a gas furnace.
6. Describe the techniques for venting different types of furnaces.
7. Explain the various draft control devices used with natural-draft furnaces.

C. Module 03203-01. Maintenance Skills for the Service Technician

1. Identify the types of threaded and non-threaded fasteners and explain their use.
2. Install threaded and non-threaded fasteners.
3. Identify the types of gaskets, packings, and seals and explain their use.
4. Remove and install gaskets, packings, and seals.
5. Identify the types of lubricants and explain their use.
6. Use lubrication equipment to lubricate motor bearings.
7. Identify the types of belt drives and explain their use.
8. Demonstrate and/or explain procedures used to install or adjust a belt drive.
9. Identify the types of couplings and explain their use.
10. Demonstrate and/or explain procedures used to remove, install, and align couplings.
11. Identify the types of bearings and explain their use.
12. Explain causes of bearing failures.
13. Demonstrate and/or explain procedures used to remove and install bearings.
14. Perform basic preventive maintenance inspection and cleaning procedures.
15. List work and personal habits that contribute to good customer relations.
16. Identify steps in the handling of a typical service call that will contribute to good customer relations.
17. Legibly fill out forms used for installation and service calls.

D. Module 03204-01. Alternating Current

1. Describe the operation of various types of transformers.
2. Explain how alternating current is developed and draw a sine wave.
3. Identify single-phase and three-phase wiring arrangements.
4. Explain how phase shift occurs in inductors and capacitors.
5. Describe the types of capacitors and their applications.
6. Explain the operation of single-phase and three-phase induction motors.
7. Identify the various types of single-phase motors and their applications.
8. Use a wattmeter, megger, capacitor analyzer, and chart recorder.

9. Test inductors and capacitors using an ohmmeter.

10. State and demonstrate the safety precautions that must be followed when working with electrical equipment.

E. Module 03205-01. Basic Electronics

1. Explain the basic theory of electronics and semiconductors.
2. Explain how various semiconductor devices such as diodes, LEDs, and photo diodes work, and how they are used in power and control circuits.
3. Identify different types of resistors and explain how their resistance values can be determined.
4. Describe the operation and function of thermistors and cad cells.
5. Test semiconductor components.
6. Identify the connectors on a personal computer.

F. Module 03206-01. Electric Heating

1. Describe and explain the basic operation of a fan coil equipped with electric heating elements.
2. Identify and describe the functions of major components of a fan coil equipped with electric heating elements.
3. Identify and describe the functions of electric heating controls.
4. Measure resistances and check components and controls for operation and safety.
5. Determine the cubic feet per minute (cfm) using the temperature rise method.
6. Describe and explain the basic operation of other electric heating systems.

G. Module 03207-01. Introduction to Control Circuit Troubleshooting

1. Explain the function of a thermostat in an HVAC system.
2. Describe different types of thermostats and explain how they are used.
3. Demonstrate the correct installation and adjustment of a thermostat using proper siting and wiring techniques.
4. Explain the basic principles applicable to all control systems.
5. Identify the various types of electromechanical, electronic, and pneumatic HVAC controls, and explain their function and operation.
6. Describe a systematic approach for electrical troubleshooting of HVAC equipment and components.
7. Recognize and use equipment manufacturer's troubleshooting aids to troubleshoot HVAC equipment.

EDUCATION

8. Exhibit competence in isolating electrical problems to faulty power distribution, load, or control circuits.

9. Identify the service instruments needed to troubleshoot HVAC electrical equipment.

10. Make electrical troubleshooting checks and measurements on circuits and components common to all HVAC equipment.

H. Module 03208-01. Accessories and Optional Equipment

1. Explain how heat transfer by conduction, convection, radiation, and evaporation relates to human comfort.

2. Explain why it is important to control humidity in a building.

3. Recognize the various kinds of humidifiers used with HVAC systems and explain why each is used.

4. Demonstrate or describe how to install and service the humidifiers used in HVAC systems.

5. Recognize the kinds of air filters used with HVAC systems and explain why each is used.

6. Demonstrate or describe how to install and service the filters used in HVAC systems.

7. Use a manometer or differential pressure gauge to measure the friction loss of an air filter.

8. Identify accessories commonly used with air conditioning systems to improve indoor air quality and reduce energy cost, and explain the function of each.

I. Module 03209-01. Metering Devices

1. Explain the function of metering devices.

2. Describe the operation of selected metering devices and expansion valves.

3. Identify types of thermal expansion valves (TXVs).

4. Describe problems associated with replacement of TXVs.

5. Describe the procedure for installing and adjusting selected TXVs.

J. Module 03210-01. Compressors

1. Identify the different kinds of compressors.

2. Demonstrate or describe the mechanical operation for each type of compressor.

3. Demonstrate or explain compressor lubrication methods.

4. Demonstrate or explain methods used to control compressor capacity.

5. Demonstrate or describe how compressor protection devices operate.

6. Perform the common procedures used when field servicing open and semi-hermetic compressors:

a. shaft seal removal and installation;

b. valve plate removal and installation;

c. unloader adjustment.

7. Demonstrate the procedures used to identify system problems that cause compressor failures.

8. Demonstrate the system checkout procedure performed following a compressor failure.

9. Demonstrate or describe the procedures used to remove and install a compressor.

10. Demonstrate or describe the procedures used to clean up a system after a compressor burnout.

K. Module 03211-01. Heat Pumps

1. Describe the principles of reverse-cycle heating.

2. Identify heat pumps by type and general classification.

3. List the components of heat pump systems.

4. Demonstrate heat pump installation and service procedures.

5. Identify and install refrigerant circuit accessories commonly associated with heat pumps.

6. Analyze a heat pump control circuit.

L. Module 03212-01. Leak Detection, Evacuation, Recovery, and Charging

1. Identify the common types of leak detectors and explain how each is used.

2. Demonstrate skill in performing leak detection tests.

3. Identify the service equipment used for evacuating a system and explain why each item of equipment is used.

4. Demonstrate skill in performing system evacuation and dehydration.

5. Identify the service equipment used for recovering refrigerant from a system and for recycling the recovered refrigerant, and explain why each item of equipment is used.

6. Demonstrate skill in performing refrigerant recovery.

7. Demonstrate or explain how to use a recycle unit.

8. Identify the service equipment used for charging refrigerant into a system, and explain why each item of equipment is used.

9. Demonstrate skill in charging refrigerant into a system.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1214 (July 2006).

§705. Level Three**A. Module 03301-02. Planned Maintenance**

1. Describe planned maintenance and service procedures required for selected HVAC equipment and components.

2. Develop a planned maintenance and service checklist for selected HVAC equipment and accessories.

3. Perform identified service and maintenance tasks on selected HVAC equipment, components, and accessories.

4. Identify the tools and materials necessary for performing service and maintenance tasks.

5. State the safety practices associated with the servicing of selected HVAC equipment, components, and accessories.

B. Module 03302-02. Troubleshooting Gas Heating

1. Describe the basic operating sequence for natural-draft and induced-draft gas heating equipment.

2. Demonstrate skill in interpreting control circuit diagrams for gas heating systems.

3. Develop a troubleshooting chart for a gas heating system.

4. Identify the tools and instruments used when troubleshooting gas heating systems.

5. Demonstrate skill in using the tools and instruments required for troubleshooting gas heating systems.

6. Isolate and correct malfunctions in gas heating systems.

C. Module 03303-02. Troubleshooting Electric Heating

1. Explain the operating principles of various types of electric heating systems.

2. Describe the ways in which electric heating systems and components are likely to fail.

3. Analyze circuit diagrams to determine the operating sequence of a fan coil equipped with electric heaters.

4. Determine the operating sequence of an electric heater package for a cooling unit or heat pump.

5. Troubleshoot:

- a. electric furnaces;
- b. accessory heater packages;
- c. baseboard heating systems;
- d. duct heaters; and
- e. radiant heating systems.

6. State the safety practices associated with the troubleshooting of selected electric heating systems.

D. Module 03304-02. Troubleshooting Oil Heating

1. Describe the basic operating sequence for oil-fired heating equipment.

2. Demonstrate skill in interpreting control circuit diagrams for oil heating systems.

3. Develop a troubleshooting chart for an oil heating system.

4. Identify the tools and instruments used in troubleshooting oil heating systems.

5. Demonstrate skill in using the tools and instruments required for troubleshooting oil heating systems.

6. Isolate and correct malfunctions in oil heating systems.

7. Describe the safety precautions that must be taken when servicing oil heating systems.

E. Module 03305-02. Troubleshooting Cooling

1. Describe a systematic approach for troubleshooting cooling systems and components.

2. Isolate problems to electrical and/or mechanical functions in cooling systems.

3. Recognize and use equipment manufacturer's troubleshooting aids to troubleshoot cooling systems.

4. Identify and use the service instruments needed to troubleshoot cooling systems.

5. Successfully troubleshoot selected problems in cooling equipment.

6. State the safety precautions associated with cooling troubleshooting.

F. Module 03306-02. Troubleshooting Heat Pumps

1. Describe the basic operating sequence for an air-to-air heat pump.

2. Demonstrate skill in interpreting control circuit diagrams for heat pumps.

3. Develop a troubleshooting chart for a heat pump.

4. Identify the tools and instruments used in troubleshooting heat pumps.

5. Demonstrate skill in using the tools and instruments required for troubleshooting heat pumps.

6. Isolate and correct malfunctions in heat pumps.

7. Describe the safety precautions associated with servicing heat pumps.

G. Module 03307-02. Troubleshooting Accessories

1. Describe a systematic approach for troubleshooting HVAC system accessories.

2. Exhibit competence in isolating problems to electrical and/or mechanical functions of HVAC system accessories.

EDUCATION

3. Recognize and use equipment manufacturer's troubleshooting aids to troubleshoot HVAC system accessories.

4. Identify and properly use the service instruments needed to troubleshoot HVAC system accessories.

5. Successfully troubleshoot problems in selected HVAC system accessories.

6. State the safety precautions associated with the troubleshooting of HVAC accessories.

H. Module 03308-02. Troubleshooting Electronic Controls

1. Describe the similarities and differences between electronic controls and conventional controls.

2. Analyze circuit diagrams and other manufacturer's literature to determine the operating sequence of microprocessor-controlled systems.

3. Use standard and special test equipment to test a microprocessor-controlled comfort system.

I. Module 03309-02. Hydronic Heating and Cooling Systems

1. Explain the terms and concepts used when working with hot-water heating, steam heating, and chilled-water cooling systems.

2. Identify the major components of hot-water heating, steam heating, chilled-water cooling, and dual-temperature water systems.

3. Explain the purpose of each component of hot-water heating, steam heating, chilled-water cooling, and dual-temperature water systems.

4. Demonstrate the safety precautions used when working with hot-water/chilled-water systems.

5. Demonstrate or describe how to operate and balance selected hot-water and chilled-water systems.

6. Describe the basic steam heating cycle.

7. Demonstrate or describe how to safely perform selected operating procedures on low-pressure steam boilers and systems.

8. Demonstrate or describe how to install and maintain selected steam traps.

9. Identify the common piping configurations used with hot-water heating, steam heating, and chilled-water cooling systems.

10. Explain the principles involved, and describe the procedures used, in balancing hydronic systems.

11. Select, calibrate, and properly use the tools and instruments needed to balance hydronic systems.

12. Read the pressure across a water system circulating pump.

J. Module 03310-02. Airside Systems

1. Explain the operating principles of different types of commercial air systems.

2. Identify the components that make up a commercial air system.

3. Describe the functions of commercial air systems and their components.

4. Identify the type of building in which a particular type of system is used.

5. Explain the typical range of capacities for a commercial air system.

K. Module 03311-02. Air Properties and Air System Balancing

1. Explain the gas laws (Dalton, Boyle, and Charles) used when dealing with air and its properties.

2. Explain how the properties of air relate to one another.

3. Use a psychrometric chart to evaluate air properties and changes in air properties.

4. Explain the principles involved in the balancing of air distribution systems.

5. Define common terms used by manufacturers when describing grilles, registers, and diffusers.

6. Identify and use the tools and instruments needed to balance air distribution systems.

7. Demonstrate and/or describe the general procedures used to balance air distribution systems.

8. Demonstrate and/or describe the methods used to change the speed of air distribution system supply fans.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1216 (July 2006).

§707. Level Four

A. Module 03401-03. Construction Drawings and Specifications

1. Read blueprints and architect's plans.

2. Compare mechanical plans with the actual installation of duct run fittings and sections.

3. Interpret specification documents and apply them to the plans.

4. Interpret shop drawings and apply them to the plans and specifications.

5. Develop cut lists for duct runs as shown on shop drawings and develop elevations of installations.

6. Describe a submittal, its derivation, routing, and makeup.

7. Develop a field set of as-built drawings.

8. Identify the steps required for transferring design information to component production.

9. Identify, develop, and complete takeoff sheets.

10. List and classify materials most commonly used in HVAC systems.

11. Complete takeoff procedures for HVAC systems.

B. Module 03402-03. Indoor Air Quality

1. Explain the need for good indoor air quality.

2. Recognize the symptoms of poor indoor air quality.

3. Perform an inspection/evaluation of a building's structure and equipment for potential causes of poor indoor air quality.

4. Identify the causes and corrective actions used to remedy the more common indoor air problems.

5. Recognize the HVAC equipment and accessories that are used to sense, control, and/or enhance indoor air quality.

6. Use selected test instruments to measure or monitor the quality of indoor air.

7. Demonstrate and/or describe the general procedures used to clean HVAC air system ductwork and components.

C. Module 03403-03. Energy Conservation Equipment

1. Recognize selected air-to-air heat exchangers and describe how they operate.

2. Recognize selected condenser heat recovery systems and explain how they operate.

3. Recognize a coil energy recovery loop and explain how it operates.

4. Recognize a heat pipe heat exchanger and explain how it operates.

5. Recognize thermosiphon heat exchangers and explain how they operate.

6. Recognize a twin tower enthalpy recovery loop system and explain how it operates.

7. Recognize airside and waterside economizers and explain how each type operates.

8. Recognize selected steam system heat recovery systems and explain how they operate.

9. Recognize an ice bank-type off-peak hours energy reduction system.

10. Demonstrate and/or describe how to operate selected energy conversion equipment.

D. Module 03404-03. Building Management Systems

1. Define a building management system.

2. Explain the operation of a basic direct digital controller.

3. Demonstrate familiarity with the terms commonly used in discussing control loops and building management systems.

4. Identify the major components of a building management system and describe how they fit together.

5. Recognize the type of information available on a typical front-end computer screen for a building management system.

6. Describe the typical steps required to install a building management system.

7. Understand how to install typical sensors, actuators, power wiring, and communication wiring.

8. Recognize what programming a building management system entails.

E. Module 03405-03. Water Treatment

1. Explain the reasons why water treatment programs are needed.

2. Recognize symptoms in heating/cooling systems that indicate a water problem exists.

3. Describe the types of problems and related remedies associated with water problems that can occur in the different types of water and steam systems.

4. Recognize and perform general maintenance on selected mechanical types of HVAC equipment that are used to control and/or enhance water quality.

5. Use commercial water test kits to test water quality in selected water/steam systems.

6. Perform an inspection/evaluation of a cooling tower or evaporative condenser to identify potential causes and/or existing conditions that indicate water problems.

7. Demonstrate and/or describe the general procedures used to clean open recirculating water systems and related cooling towers.

8. Demonstrate and/or describe the general procedures used to inspect, blowdown, and clean steam boilers.

F. Module 03406-03. System Startup and Shutdown

1. Demonstrate and/or describe how to prepare a boiler for dry storage.

2. Demonstrate and/or describe how to prepare a boiler for wet storage.

3. Demonstrate and/or describe how to clean, start up, and shut down a steam boiler.

4. Demonstrate and/or describe how to clean, start up, and shut down a hot-water boiler.

5. Demonstrate and/or describe how to start up and shut down a reciprocating liquid chiller and related water system.

6. Demonstrate and/or describe how to start up and shut down a selected centrifugal or screw liquid chiller and related water system.

EDUCATION

7. Demonstrate and/or describe how to start up and shut down an air handler and related forced-air distribution system.

8. Demonstrate and/or describe how to test compressor oil for acid contamination.

9. Demonstrate and/or describe how to add or remove oil from a semi-hermetic or open reciprocating compressor.

10. Demonstrate and/or describe how to inspect and clean shell and tube condensers/evaporators and other water-type heat exchangers.

G. Module 03407-03. Heating and Cooling System Design

1. Identify and describe the steps in the system design process.

2. From blueprints or an actual job site, obtain information needed to complete heating and cooling load estimates.

3. Identify the factors that affect heat gains and losses to a building and describe how these factors influence the design process.

4. With instructor supervision, complete a load estimate to determine the heating and/or cooling load of a building.

5. State the principles that affect the selection of equipment to satisfy the calculated heating and/or cooling load.

6. With instructor supervision, select heating and/or cooling equipment using manufacturers' product data.

7. Recognize the various types of duct systems and explain why and where each type is used.

8. Demonstrate the effect of fittings and transitions on duct system design.

9. Explain the use and installation of diffusers, registers, and grilles used in duct systems.

10. Demonstrate the use of a friction loss chart to size round duct.

11. Demonstrate the use of duct sizing tables to size rectangular duct.

12. Explain or demonstrate the use and installation of insulation and vapor barriers used in duct systems.

13. Apply proper design principles to the selection and installation of refrigerant and condensate piping.

14. Estimate the electrical load for a building and calculate the effect of the comfort system on the electrical load.

H. Module 03408-03. Commercial and Industrial Refrigeration

1. Recognize the different types of refrigerated coolers and display cases. For each type, give its common application.

2. Compare the basic components used in commercial/industrial refrigeration systems with those used in comfort air conditioning systems.

3. Recognize single, multiple, and satellite compressor systems. Describe the applications, installation considerations, and advantages and disadvantages of each type.

4. Recognize packaged condensing units and unit coolers. Describe their applications, operation, and installation considerations.

5. Recognize two-stage compressors. Explain their operation and applications.

6. Recognize the various accessories used in commercial refrigeration systems. Explain why each is used and where it should be installed in the system.

7. Recognize the various refrigeration control devices. Explain the purpose of each type and how it works.

8. Describe the various methods used to defrost evaporators.

9. Recognize ice cube and ice flake making machines. Describe their operation and installation considerations.

10. Describe the characteristics and properties of the refrigerants and oils being used to replace CFC refrigerants and mineral oils in existing systems.

11. Demonstrate or describe the general procedure for retrofitting a CFC refrigeration system to use an HCFC or HFC refrigerant.

12. Recognize basic ammonia refrigeration systems. Compare the components used in ammonia systems with those used in halocarbon-based refrigerant systems.

AUTHORITY NOTE: Promulgated in accordance with R.S. 17:6(A)(10).

HISTORICAL NOTE: Promulgated by the Board of Elementary and Secondary Education, LR 32:1218 (July 2006).